

The surface kinetic properties between $\text{BCl}_3/\text{Cl}_2/\text{Ar}$ plasma and Al_2O_3 thin film

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Abstract : To keep pace with scaling trends of CMOS technologies, high-k metal oxides are to be introduced. Due to their high permittivity, high-k materials can achieve the required capacitance with stacks of higher physical thickness to reduce the leakage current through the scaled gate oxide, which make it become much more promising materials to instead of SiO_2 . As further studying on high-k, an understanding of the relation between the etch characteristics of high-k dielectric materials and plasma properties is required for the low damaged removal process to match standard processing procedure. There are some reports on the dry etching of different high-k materials in ICP and ECR plasma with various plasma parameters, such as different gas combinations (Cl_2 , Cl_2/BCl_3 , Cl_2/Ar , SF_6/Ar , and $\text{CH}_4/\text{H}_2/\text{Ar}$ etc). Understanding of the complex behavior of particles at surfaces requires detailed knowledge of both macroscopic and microscopic processes that take place; also certain processes depend critically on temperature and gas pressure. The choice of BCl_3 as the chemically active gas results from the fact that it is widely used for the etching of the materials covered by the native oxides due to the effective extraction of oxygen in the form of BCl_xO_y compounds.

In this study, the surface reactions and the etch rate of Al_2O_3 films in $\text{BCl}_3/\text{Cl}_2/\text{Ar}$ plasma were investigated in an inductively coupled plasma(ICP) reactor in terms of the gas mixing ratio, RF power, DC bias and chamber pressure. The variations of relative volume densities for the particles were measured with optical emission spectroscopy (OES). The surface imagination was measured by AFM and SEM. The chemical states of film was investigated using X-ray photoelectron spectroscopy (XPS), which confirmed the existence of nonvolatile etch byproducts.

Key Words: Kinetic properties, plasma, $\text{BCl}_3/\text{Cl}_2/\text{Ar}$, Al_2O_3 ,